SILVA BALCANICA

Silva Balcanica 24(2): 45-57 (2023)
doi: 10.3897/silvabalcanica.24.e106658

RESEARCH ARTICLE

Assessment and mapping the potential of mountain ecosystems in "Pirin" NP to provide "Cultural heritage"

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Academic editor: Georgi Georgiev | Received 19 May 2023 | Accepted 27 June 2023 | Published 29 August 2023

Citation: Glushkova M., Zhiyanski M., Yaneva R. 2023. Assessment and cultural ecosystem service mapping in mountain protected areas – "Pirin" National park. Silva Balcanica 24(2): 45-57. https://doi.org/10.3897/silvabalcanica.24.e106658

Abstract

The assessment and mapping of ecosystems and their services is considered an important action that effectively contributes to proper understanding of how ecosystems support human well-being, and furthermore – to promote the sustainable use of natural resources. The diversity of cultural landscapes, especially in mountain areas, is a significant prerequisite for a variety of cultural ecosystem services that are valuable for the society. This evaluation is the basis for environmental management practices and policymaking. The study presents an approach for assessment and mapping of cultural ecosystem service (CES) "Cultural heritage" that is recognised as important and is provided by mountain protected areas (PAs) in "Pirin" National Park. The data from the Management Plan of "Pirin" NP were used for characterization and biophysical assessment of the condition of forest ecosystems and their potential to provide CESs. The analysis of the results revealed that the conservation regime allowed the territories to preserve a high degree of naturalness and a very good ecological condition as 94.80% of forest ecosystems are assessed with score 4 –"good" condition and 0.44% are with "very good" condition – score 5. The majority of forest ecosystems with "very good" ecological condition are *Pinus peuce* forests, located mainly on the territory of the reserves "Bayuvi Dupki- Dzhindzhiritsa" and "Yulen", proving the importance of the protective regime of the territories. Forest ecosystems with average and high capacity to provide ES "Cultural heritage" prevailed, which is consistent with well-preserved and unique nature, the diversity of landscapes, and species richness. Considerable areas were assessed with score 5 – very high capacity, mostly on the territory of the reserves "Bayuvi Dupki- Dzhindzhiritsa" and "Yulen", and at the foothill of the huts.

Keywords

assessment, condition, cultural heritage, ecosystem services, mapping, protected areas

Introduction

The idea of protecting and restoring the benefits that ecosystems provide to people has been promoted through the EU 2020 Biodiversity Strategy, and since then the assessment and mapping of ecosystems and their services is perceived as an important activity that can effectively contribute to understanding how ecosystems support human well-being, and furthermore – to promote the sustainable use of natural resources (Burkhard & Maes, 2017). Fostering the maintenance of a broad range of ecosystem services has become a dominant environmental paradigm that has opened up important conservation opportunities around the world (de Groot et al., 2010).

Numerous studies underline the importance of "ecosystems' contributions to the non-material benefits that arise from human–ecosystems relationships" (Chan et al., 2012) and are in general less directly linked to human well-being than provisioning and regulating services (Millennium Ecosystem Assessment, 2005). In the case of cultural ecosystem services (CESs), it is essential to address the socio-cultural preferences (Bullock et al., 2018; Iniesta-Arandia et al., 2014; Martín-López et al., 2012; Raymond et al., 2014) which proper management as quantified indices remains a significant challenge (Scholte et al., 2015).

Given the importance of cultural services for developed societies, it is surprising that cultural services – with the exception of recreation and tourism – are rarely considered in ecosystem services assessments (Feld et al., 2009). Also, cultural services do not represent purely ecological phenomena, but rather are the outcome of complex and dynamic relationships between ecosystems and humans in landscapes over long time spans (Fagerholm et al., 2012). They are difficult to quantify in biophysical assessments, and their economic evaluation is generally subject to controversy. Moreover, their normative nature and the heterogeneity of their valuation by various stakeholders provide additional challenges (Rambonilaza & Dachary-Bernard, 2007; van Berkel & Verburg, 2012).

The diversity of cultural landscapes, especially in mountain areas, is an important prerequisite for a variety of cultural ecosystem services. This evaluation is the basis for various environmental management and policymaking for nature-based activities and tourism destinations diversification, including in protected areas (Müller et al., 2019). In addition to recreational opportunities, aesthetic landscape enjoyment and inspiration (Oteros-Rozas et al., 2018; Pastur et al., 2016; Schirpke et al., 2017, 2018), mountain landscapes offer many less commodified CESs, such as national identity, landscape memory, therapeutic forests, heirloom traditions, rituals, and spirituality (Robbins & Berkes, 2000; Sarmiento & Cotacachi, 2019).

On the other hand population growth, urbanization (Dickinson & Hobbs, 2017), land-use changes that modify ecosystems for more food, fibre, or energy production (Cumming et al., 2014) as well as climate change (Berrouet et al., 2018) alter socio-ecological systems (SES) in mountain regions. Resulting landscape changes may threaten the provision of CESs and provoke conflicts among different stakeholders (Bender & Haller, 2017; Starrs, 2018).

Therefore, in this study, assessment and mapping of cultural ecosystem service "Cultural heritage" that is considered as important and is provided by mountain protected areas (PAs) in "Pirin" National Park, were performed, as recognizing, demonstrating and capturing the value of ecosystem services can play an important role in setting policy directions for ecosystem management, conservation and restoration of biodiversity, identified as major benefits to the society and economy and thus in increasing the provision of ecosystem services and their contributions to human well-being.

Materials and methods

Study Area Description

National Park "Pirin" encompasses the larger part of Pirin Mt. in southwestern Bulgaria, spanning an area of 40 332.4 ha (Order No. RD – 395 of 15 October 1999 of the Ministry of Environment and Water). Two nature reserves are included within the national park – "Bayuvi Dupki – Djinjiritsa", which is one of the oldest reserves in Bulgaria, and "Yulen" (Fig. 1). "Bayuvi Dupki – Djinjiritsa" is a part of the network of biosphere reserves under the "Man and Biosphere" program of UNESCO. In 1983 NP "Pirin" was included in the list of the Convention on the Protection of World Heritage by UNESCO, confirming the exceptional value of the nature in the park.

"Pirin" NP is characterised with specific alpine territories, rich biodiversity, with many endemic and relict plant and animal species. A total of 1341 species and intraspecific taxa have been identified on the territory of the park, which represents about 32.6% of the flora of Bulgaria (MP, 2016). Forests cover around 57.3% of the total area of the park. 95% of the forest are coniferous and 5% – deciduous. The largest area is dominated by dwarf mountain pine (*Pinus mugo* Turra), followed by Norway spruce (*Picea abies* Karst.), European beech (*Fagus sylvatica* L.) and Bosnian pine (*Pinus heldreichii* Crist.). Two subendemic tree species are distributed in the zone between the upper tree-line and timberline, situated mostly between 1900 and 2250 m a.s.l. – the Macedonian pine (*Pinus peuce* Gris.) on silicate sites and the Bosnian pine (*Pinus heldreichii* Crist.) on carbonate rock.

Three vegetation belts are diferentiated on the territory of "Pirin" National Park – forest, subalpine and alpine. The vegetation in the forest belt is represented by some of the most typical and widely distributed coniferous forest species in Bulgaria – *Pinus sylvestris* L., *Pinus nigra* Arn. and *Abies alba* Mill. The vegetation in the subalpine vegetation belt largely resembles the corresponding vegetation in Rila Mt. with typical plants *Pinus mugo* Turra and *Juniperus communis* L. The alpine vegetation belt is very well-expressed and is one of the most diverse for the entire country. Many endemic species are found here, regardless of the fact that large territories are covered with grass vegetation and rocks.

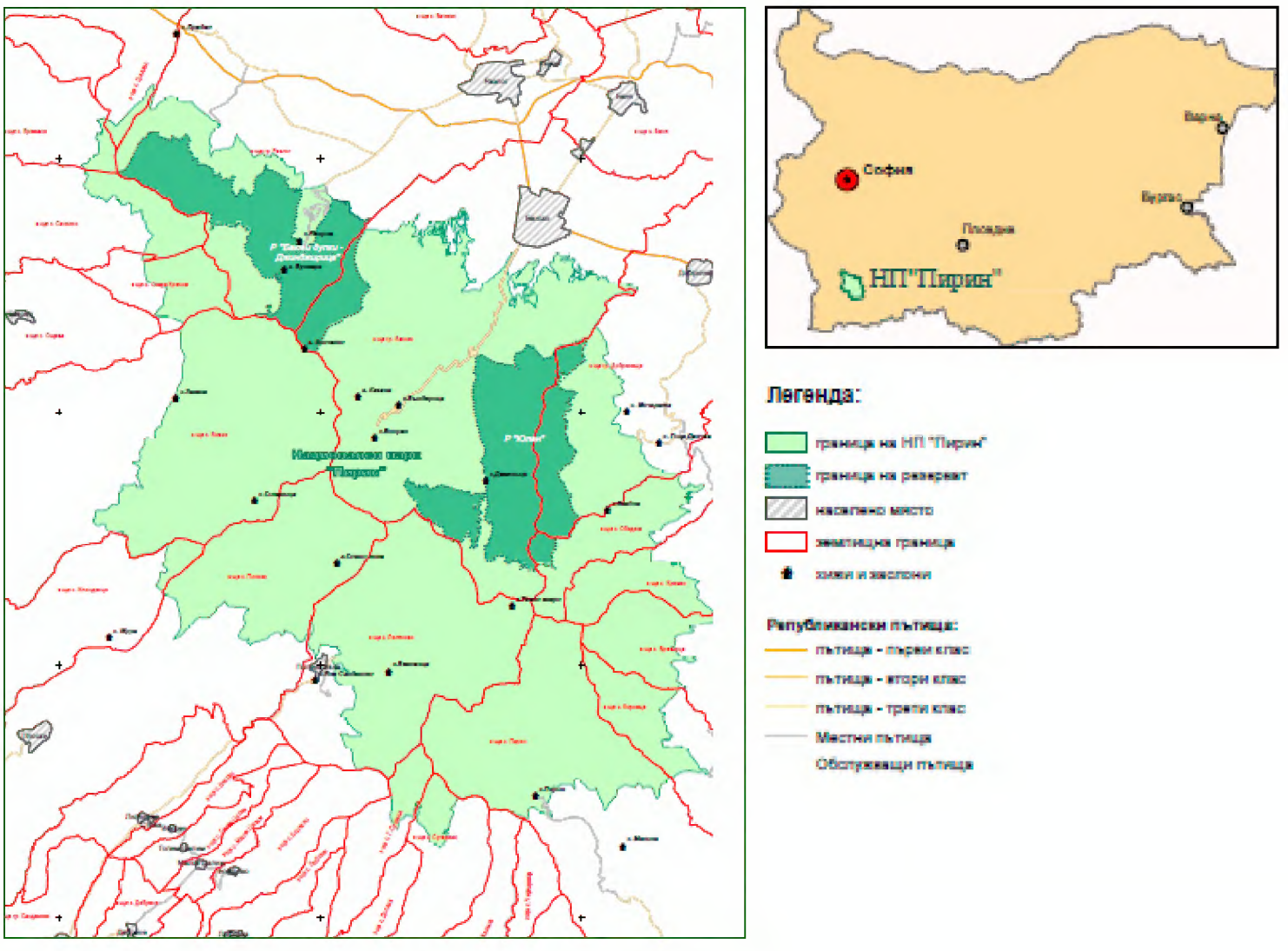

Figure 1. Case-study area – "Pirin" National Park (MP, 2016)

Data collection and processing

The proper identification of ecosystem types requires the use of reliable typology. In the present study the MAES typology was organized in two main levels. Its structure enables applying CORINE Land Cover (CLC) data for spatial delineation and is also adjusted with the European Nature Information System (EUNIS) habitat classification types. The main classes of the typology proposed by MAES were used for the differentiation, assessment and mapping of the condition of mountain ecosystems and the services they provide in "Pirin" NP (Maes, 2013). The ecosystem types in high mountain territories in the park at Level 2 were determined as follows: Urban, Grassland, Woodland and forest, Heathland and shrubs, Sparsely vegetated land, Rivers and lakes.

The data from Management Plan of "Pirin" National Park (MP, 2016) were used for characterization and biophysical assessment of the condition of forest ecosystems. A set of informative indicators to quantify the condition of ecosystems were selected, based on the "Methodology for assessment and mapping of woodland and forest ecosystems condition and their services in Bulgaria" which indicates in detail and step by step the collection and identification of basic data, including indicators with their respective parameters (Kostov et al., 2017). The selected indicators have to be able

to provide useful information to policy makers, different stakeholders and the wider public on the current state and changes in the conditions of the environment. The indicators included the main five groups: Biotic diversity, Abiotic heterogeneity, Energy budget, Matter budget and Water budget with a particular number of individual indicators and specified parameters.

The condition of the ecosystems was assigned with scores from 1 (bad condition) to 5 (very good condition), depending on the measured/assessed values of every indicator (by expert evaluation for each specific polygon). The Index of Performance (IP) for a particular ecosystem was used in order to collate all separate indicator scores into one single measure of ecosystem structural-functional condition. The IP was calculated as the ratio of the sum of the indicator scores to the maximum possible indicator sum:

$$IP = Sni/Sni(max) \quad (1)$$

where:

Sni – sum of the scores, assigned to every indicator;

Sni(max) – sum of the maximum possible indicator (score 5) for every indicator.

The IP takes values between 0 and 1, according to the following scale: IP = 0.00 ÷ 0.20 – very bad condition; IP = 0.21 ÷ 0.40 – bad condition; IP = 0.41 ÷ 0.60 – moderate condition; IP = 0.61 ÷ 0.80 – good condition; IP = 0.81 ÷ 1.00 – very good condition.

The importance of various variables underlying the cultural ecosystem services in mountainous protected areas (PAs) were assessed based on perception evaluation of scientists and local stakeholders through a questionnaire and further prioritization. The appropriate ecosystem service "Cultural heritage" was selected for assessment and mapping, based on: availability of information, accessibility, completeness and appropriate format of information.

The assessment of the potential of mountain ecosystems in "Pirin" NP to provide ES "Cultural heritage" was based on the "Methodology for assessment and mapping of the condition of woodlands and forest ecosystems and ecosystem services in Bulgaria" and was made according to the Forest Ecosystem Services (FES) mapping at national park scale methodology (Mallinis et al., 2020), tested in pilot mountain transboundary areas, and the methodology of Petz et al. (2016), developed by the Netherlands Environmental Agency (Table 1).

The cultural ES "Cultural heritage" belongs to the CICES Class "Characteristics of living systems that are resonant in terms of culture or heritage" with code 3.1.2.3. (CICES, 2018). The assessment of cultural/natural heritage was carried out through a systematic analysis of the importance and significance of natural resources for different groups of stakeholders. The approach for analysis and assessment of "Cultural heritage" as an ecosystem service was also based on the data for the indicator – distance from the road network, giving rather a real qualitative characteristic of the territory, showing which places are easily accessible for transport and the best places for different type of tourism activities, recreation, education and aesthetic enjoyment of mountain landscapes.

Table 1. The main characteristics of "Cultural heritage" model

Indicator name	Cultural heritage
CICES V5.1 code	3.1.2.3.
Short description	Sites relevant to local history and culture
Units	Scale 1-10
Spatial resolution	Grid
Output maps	Cultural heritage
Data	Points of cultural interest, road network, DEM
Main References	Ferrari, M., Geneletti, D., 2014. Mapping and Assessing Multiple Ecosystem Services in an Alpine Region: a Study in Trentino, Italy. Ann. di Bot. 4, 65–71. https://doi.org/10.4462/annbotrm-11729

Mapping procedure

The generated maps were set in a UTM coordinate system by using the ESRI ArcGIS software. Forest data was retrieved from the Management Plan of "Pirin" National Park and transferred into a uniform database for further analysis. The mapping procedure for the forest ecosystem condition assessment comprised a 2-tier approach in order to provide flexibility and completeness of the overall assessment. Tier 1 represents assessment based on biophysical indicators with scores from 1 to 5 for each indicator in regards to the data for the specific parameter per subunit (smallest mapping unit). Tier 2 consists of GIS analysis and application of spatial analysis tools. The territories occupied by forests on subunit level outline polygons that have been related spatially to the corresponding score 1-5.

Data from Open street map and LCA Database were used for the mapping of CES "Cultural heritage". The accessibility to cultural heritage sites depends on their proximity to the road network and their density. The normalized Euclidean distance, using minimum and maximum values, has been computed from the road network to each cultural heritage site. The density of the cultural heritage sites was estimated using Kernel density analysis.

Results and discussion

Three main subtypes of forest ecosystems at level 3 of the European Nature Information System (EUNIS) habitat classification types were identified in the study area in "Pirin" NP (Table 2): G1 (High deciduous forests), G3 (Coniferous) and G4 (Mixed deciduous and coniferous woodland). At level 4 respectively, 6 subtypes of forest ecosystems were identified, corresponding to the specific types of Natura 2000 habitats. Heatland and shrub ecosystems are presented by 1 subtype F2 "Arctic, alpine and subalpine", corresponding to habitat type 4070*, which is of conservation priority in Europe.

Table 2. Ecosystem typology and correspondence of habitat types with MAES ecosystem categories and types (level 2, 3 and 4)

Level 2	Level 3	Level 4	Natura 2000 Habitat types' codes
Woodland and forest	High deciduous forests – G 1	G 1.6.	9110, 9130
	Coniferous – G 3	(G 3.1+G 3.4+G 3.5+G 3.6)	91BA, 91CA, 9410, 95AO, 9530*
	Mixed deciduous and coniferous woodland – G 4	G 4.6.	
Heatland and shrub	Arctic, alpine and subalpine – F 2	F 2.4.	4070*

Note: asterisk (*) indicates habitat types of conservation priority in Europe

The most widespread are F2.4. "Conifer scrub close to the tree limit", as well as G3.6 "Subalpine Mediterranean *Pinus* woodland", followed by G3.4. "Fir and spruce woodland".

The habitat type of conservation priority **4070 *Bushes with *Pinus mugo*** occurs both in the territories of the "Bayuvi Dupki – Djinjiritsa" and "Yulen" reserves, as well as in the rest of the park with a total area of about 7 400 ha. In contrast, the other priority habitat **9530 *Sub-Mediterranean pine forests with endemic black pines** are spread on the territory of the "Bayuvi Dupki – Djinjiritsa" reserve and in a small part of the remaining park territory with a total area of about 170 ha.

The analysis of the results from the biophysical assessment of the condition of forest ecosystems in "Pirin" National Park revealed that the conservation regime allowed the territories to preserve a high degree of naturalness and very good ecological condition as 94.80% of forest ecosystems are assessed with score 4 -"good" condition and 0.44% are with "very good" condition – score 5 (Fig. 2).

The largest part of forest ecosystems with "very good" ecological condition are *Pinus peuce* forests and most of them are located on the territory of two reserves "Bayuvi Dupki- Dzhindzhiritsa" and "Yulen", proving the importance of the protective regime of the territories. Only 4.76% of the ecosystems are assessed with score 3 – "moderate" condition, but no special attention is required for their management at this stage. Regardless of the results, regular control on the intensity of land use in mountain regions needs to be performed, as well as on the direct influence on the condition and spatial structure of the ecosystems including pastoral livestock farming, mixed agricultural land, construction, tourist and sports infrastructure and services.

The studied forest ecosystems provide a wide variety of cultural ecosystem services, as the well-preserved nature is an important prerequisite for the development of different forms of tourism and recreation.

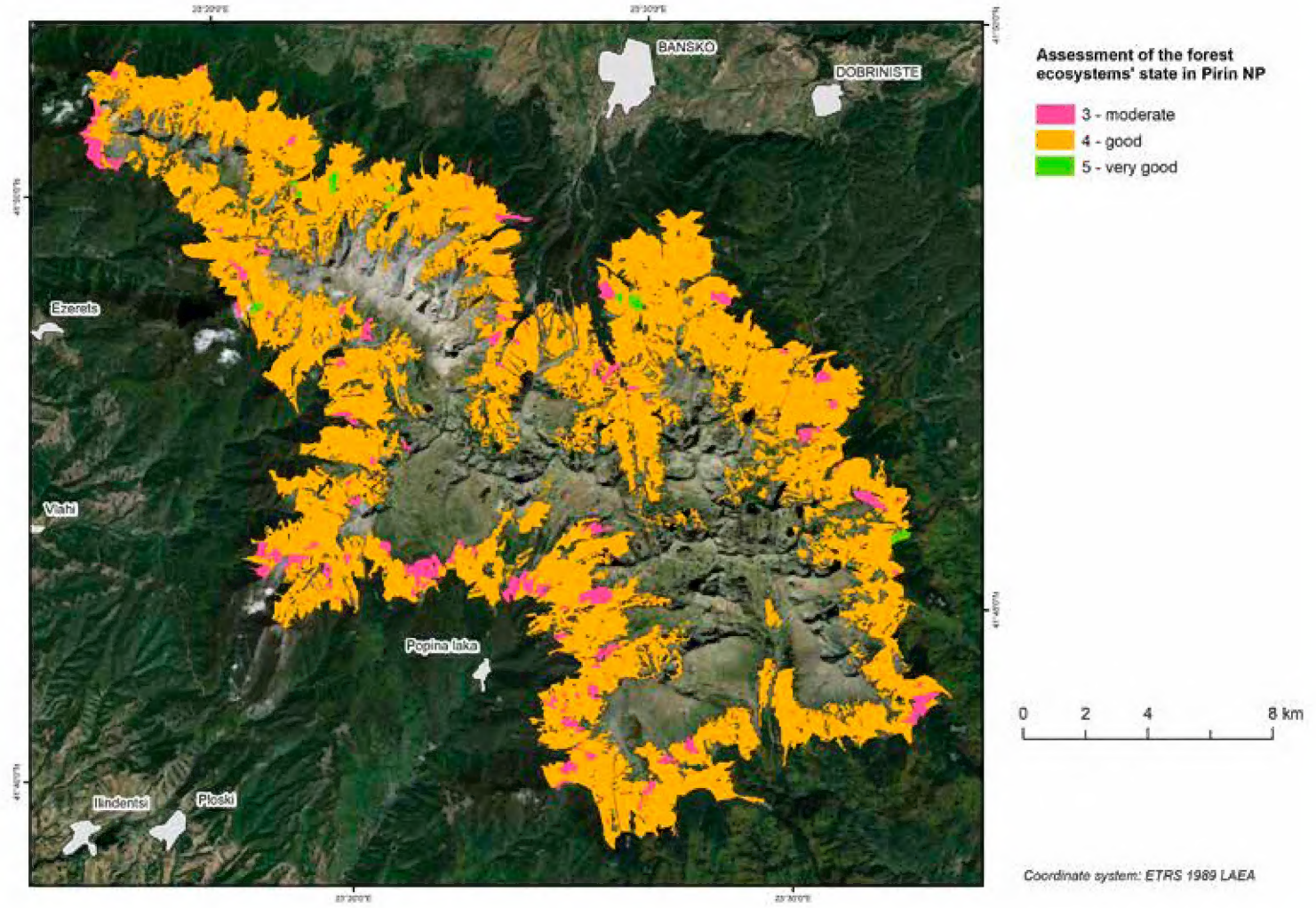

Figure 2. Assessment of forest ecosystems condition in "Pirin" NP

"Pirin" NP is a very popular tourist destination including all of the categories of the tourist resource – local, regional, national and international. The recreational-tourist and sports resource of the Park is the main factor that attracts visitors to the mountain and the region. The natural objects prevail in the park with diverse landscapes, a large part of which is reachable by established road network and tourist routes with varying distance and difficulty. The main approaches from the settlement to the huts in "Pirin" National Park and in the region are a total of 27 and also 31 tourist hut to hut routes are known.

The two reserves within the boundaries of the park, under the special regime of protection, make an exception. Passing tourists through their territory is regulated in the announcement orders of the reserves or under the legal order relevant to the conservation purposes. The anthropogenic objects (buildings, infrastructure, sports facilities, etc.) are derived from natural ones, facilitating the needs of visitors according to their purpose – tourism, recreation, sports etc. The tourist product (tourism, sport, recreation, services, advertising, etc.) in the park and in the region is a major factor for the economic prosperity, living standard and well-being of the population.

The potential of forest territories in "Pirin" NP to provide ES "Cultural heritage" was assessed taking into account different types of landscapes, tourist attractions, the presence of water bodies, specific characteristics of the relief, visual properties, etc. The analysis of the results highlights the spatial distribution of ecosystems with rel-

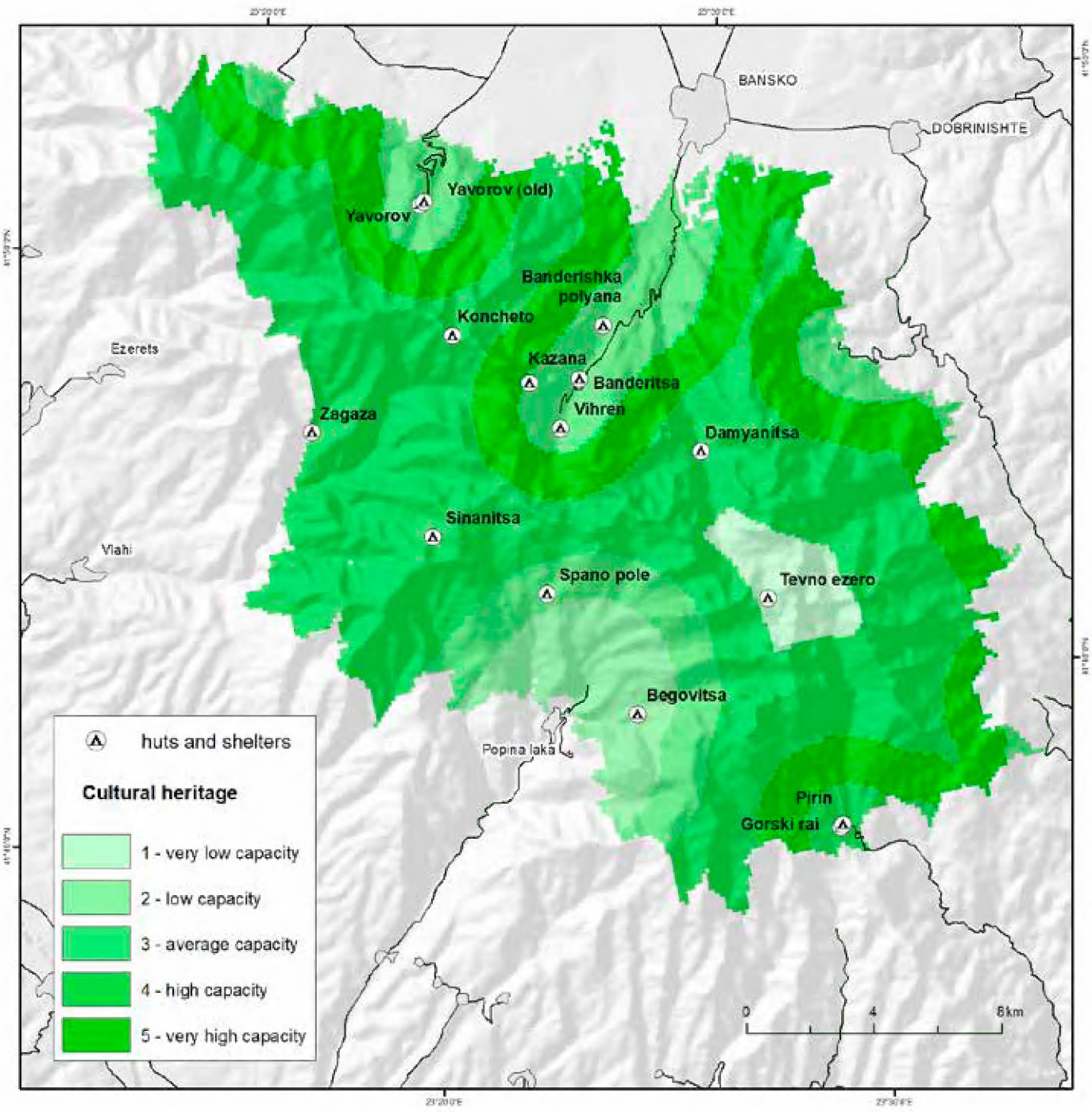

Figure 3. Potential of ecosystems to provide ES "Cultural heritage"

evant potential to provide ES "Cultural heritage". The majority of forest ecosystems in "Pirin" NP are characterized with average and high capacity which is consistent with well-preserved and unique nature, the diversity of landscapes, and habitats, and species richness (Fig. 3). Considerable areas were assessed with score 5 – very high capacity, mostly on the territory of the reserves "Bayuvi Dupki- Dzhindzhiritsa" and "Yulen", and at the foothill of the huts "Yavorov", "Banderitsa", "Sinanitsa", "Damyanitsa" and "Pirin", as well as in the region of Banderishka polyana, and especially areas combined with mountain lakes. No territories were identified with very low capacity to provide ES "Cultural heritage".

The summary of the results from assessment of the potential of mountain ecosystems in "Pirin" NP to provide "Cultural heritage" showed that the region offers an exceptional and well preserved nature, richness of forests, rivers and plenty of glacial

lakes, favorable climate for leisure walks, relaxation and healing. The high scores obtained for a large part of the park's territory emphasised the key role of protected areas (PAs) for nature conservation underlining the primary importance of the natural self-development of the ecosystems for the provision of their inherent functions which are the foundation for the supply of a variety of ecosystem services.

Many studies have examined the relationship between biodiversity, ecosystem condition and ESs supply (Quijas et al. 2010; Duru et al. 2015; Pastur et al. 2016) and stated that the highest capacity of ESs provision is detected in natural habitat, rich in biodiversity, in good condition and absence of pressures (Manolaki and Vogiatzakis, 2017). However, up to now, there is a lack of quantitative data linking ecosystem condition to the ecosystem potential capacity to deliver services (Erhard et al. 2016; Maes et al. 2016) but the existing datasets of biodiversity and anthropogenic pressures could be used to reveal this link (Maes et al., 2016).

This of course, also raises the issue of updating the information directed to mountain communities on the functions of protected areas as spatial natural capital assets that purposefully and actively support their prioritized habitat maintenance, biodiversity conservation and great capacity to provide provisioning, regulating, and cultural ecosystem services in significant geographic areas.

On the other hand, mountain PAs also contribute to the territorial development in socio-economic aspects providing employment to the local population, development of tourism and recreation, eco-friendly livelihood, infrastructure, R&D, and education.

Conclusions

The assessment and mapping of ecosystem services can significantly contribute to better understanding the importance of ecosystems to human well-being and to provoke a discussion on the need for the implementation of nature-based measures in regional and local planning for territorial development and sustainable use of natural resources.

The analysis of the results from the assessment of the condition of forest ecosystems in "Pirin" NP revealed that the largest part of them is characterized with good and very good ecological condition and high degree of naturalness, emphasizing the importance of the conservation regime. The studied mountain ecosystems provide a wide variety of cultural ecosystem services, as the well-preserved nature in Pirin Mt. is an important prerequisite for the development of different form of tourism and recreation.

The majority of ecosystems in "Pirin" NP are characterized with average and high capacity to provide CES "Cultural heritage". Considerable areas were assessed with very high capacity, mostly on the territory of the reserves "Bayuvi Dupki- Dzhindzhiritsa" and "Yulen", and at the foothill of the main mountain huts.

Although the PAs's objectives are mainly conservation-oriented having direct impacts on the preservation of natural resources and the natural heritage within its boundaries, the diversity of different protected areas and landscapes has a considerable potential for the development of ecotourism and of sustainable use of the abundant natural resources.

It could be noted that PAs could influence territorial development by shaping/influencing strategies and policies, by implementing projects or strategies, and by sharing knowledge and coordinating different actors. In addition, the recognition, assessment and mapping of ecosystem services from PAs network can significantly influence stakeholders' attitudes and can directly support the decision-makers in their planning activities to achieve sustainable utilization of ecosystem services and to keep the balance between environmental protection, and socio-economic development.

Acknowledgements

This study was performed under the project "ASSESSMENT AND MAPPING OF ECOSYSTEM SERVICES IN HIGH-MOUNTAIN TERRITORIES IN RILA AND PIRIN FOR SUSTAINABLE MANAGEMENT OF NATURAL RESOURCES" – MAPESMOUNT, funded by Bulgarian National Science Fund, under grant agreement No КП-06-ОПР 03/6/17.12.2018.

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